Detecting toxic *Microcystis* in the lower Great Lakes

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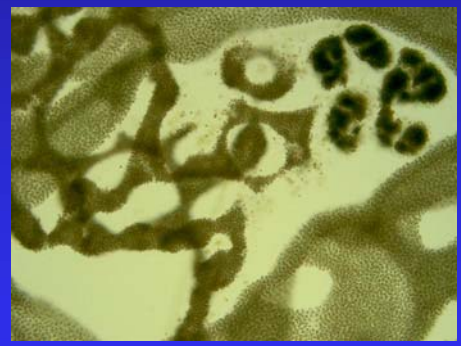
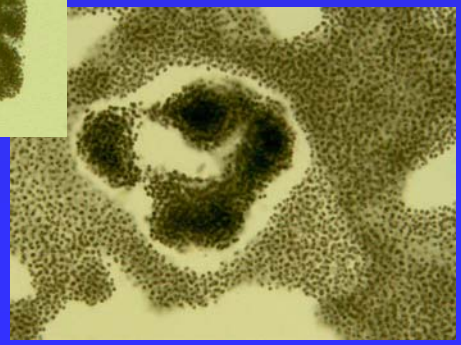
Microcystis in the Great Lakes

- Colonial cyanobacterial HAB
- Forms blooms and scums
  - Taste/odor issues in drinking water
  - Loss of recreational and fishing value to affected waters
  - Blooms can be toxic or non-toxic





Microcystis

Put-In-Bay, Lake Erie

What makes a cyanobacterial bloom toxic?

- Shift in community composition

Mostly non-toxic

Mostly toxic strains

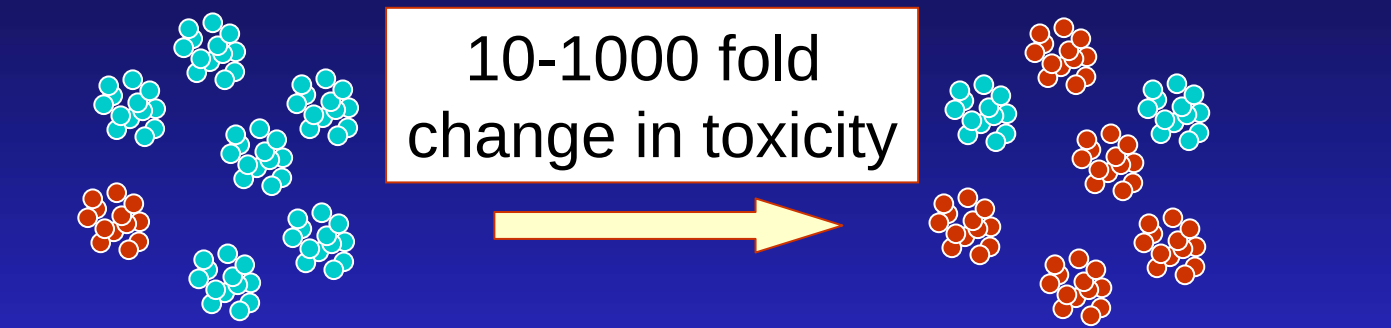
- Stimulation of toxin production by environmental factors

Not producing toxin

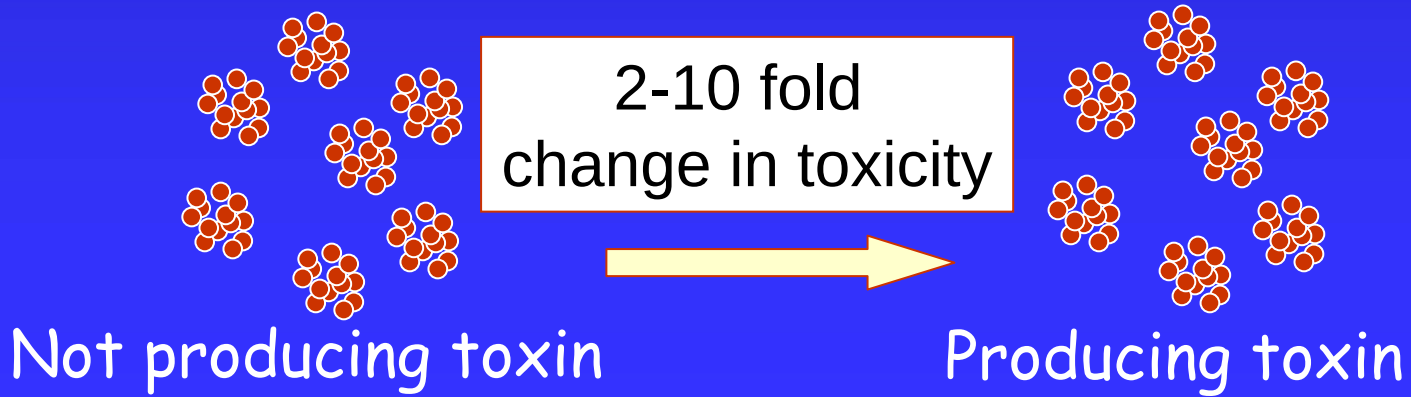
Producing toxin

What makes a cyanobacterial bloom toxic?

- Shift in community composition



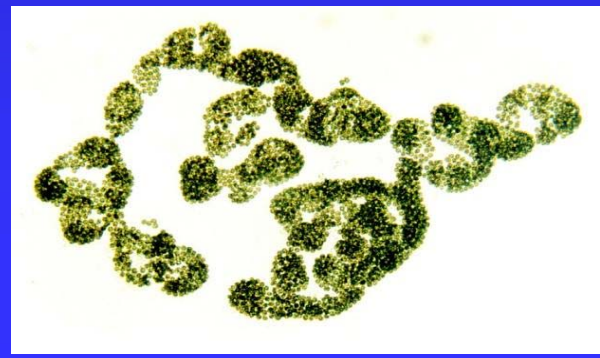
- Stimulation of toxin production by environmental factors



(Zurawell et al 2005)

Current projects

- Map microcystin concentrations and *Microcystis* cell numbers in Saginaw Bay and western Lake Erie
- Identify environmental factors promoting microcystin production
- Develop rapid methods for detection of toxic *Microcystis*
- Accumulation in fish

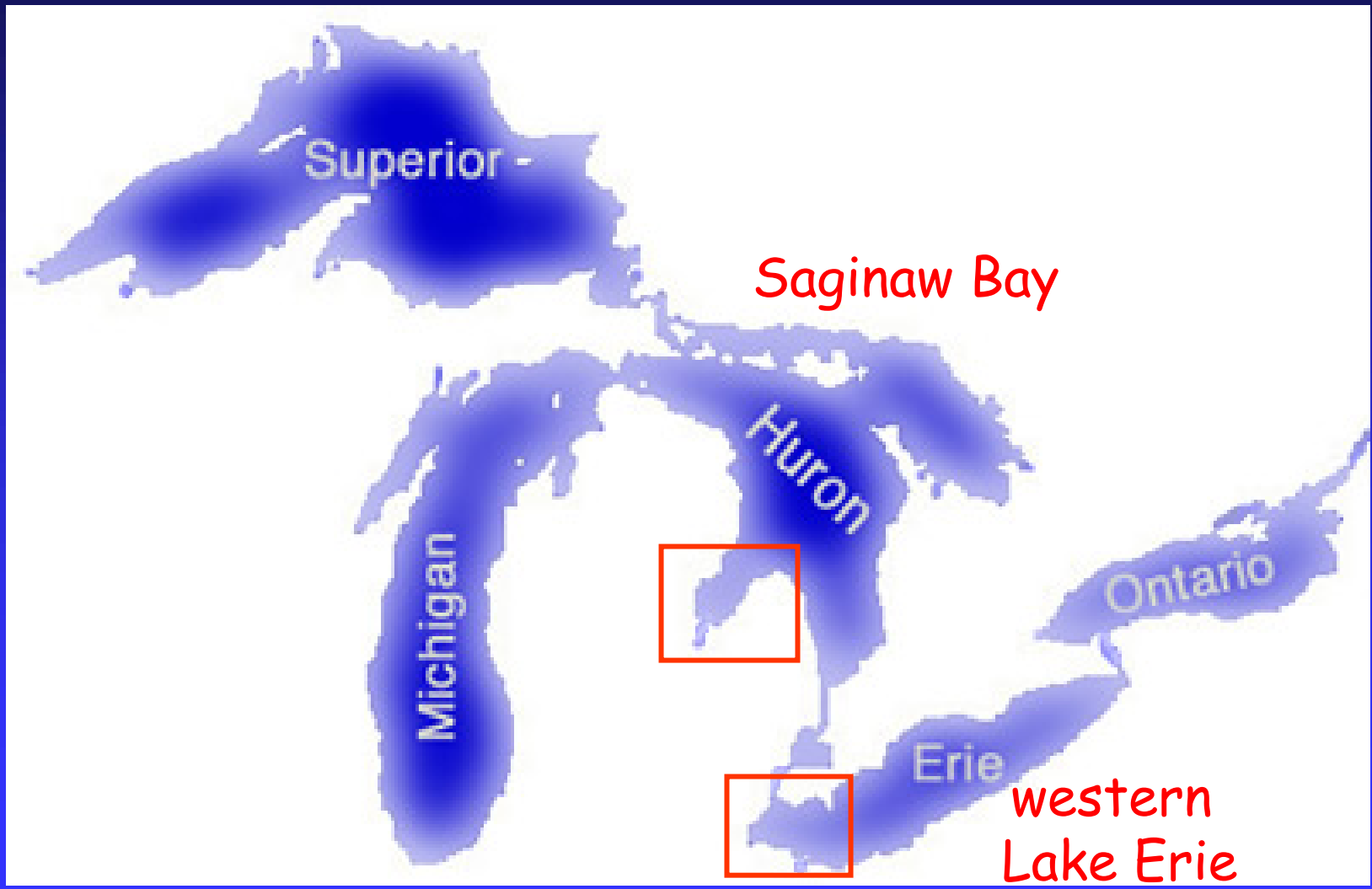


Microcystis sp.

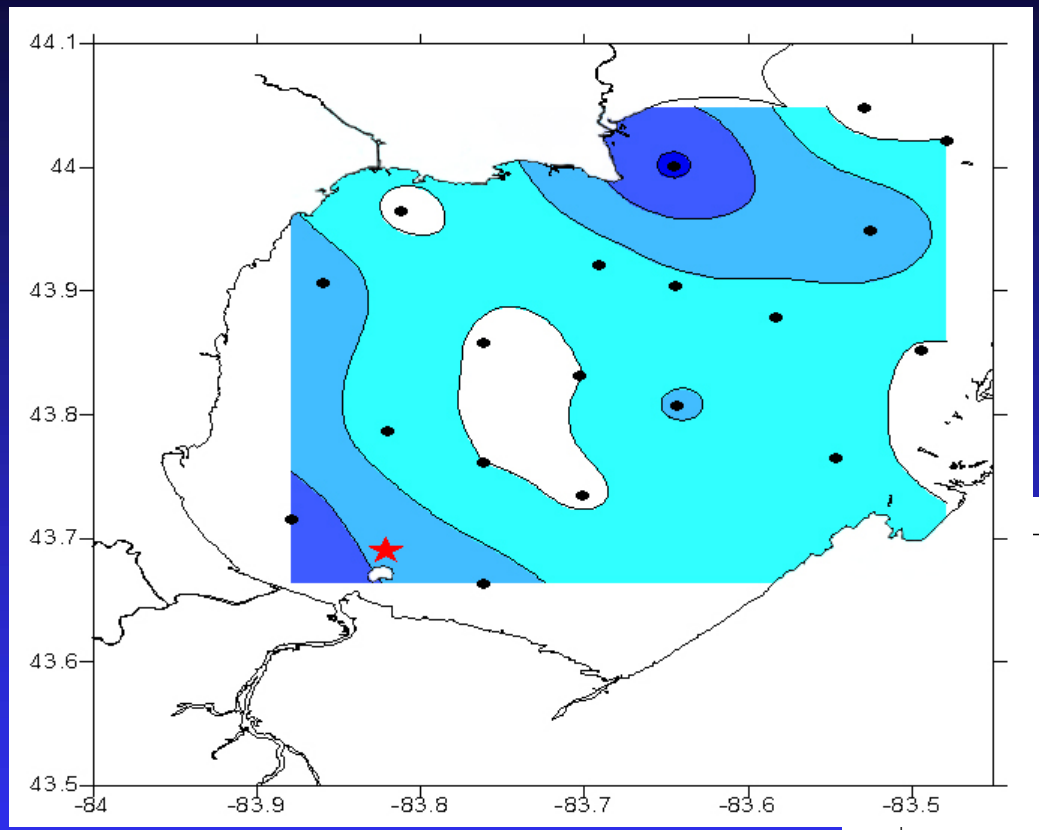
Goal

- Develop predictive capabilities for presence of toxic cyanobacterial blooms in Great Lakes recreational and drinking water supplies

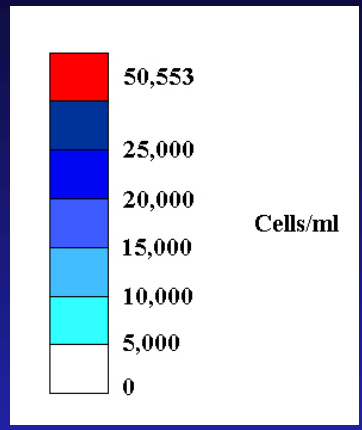
Sampling sites



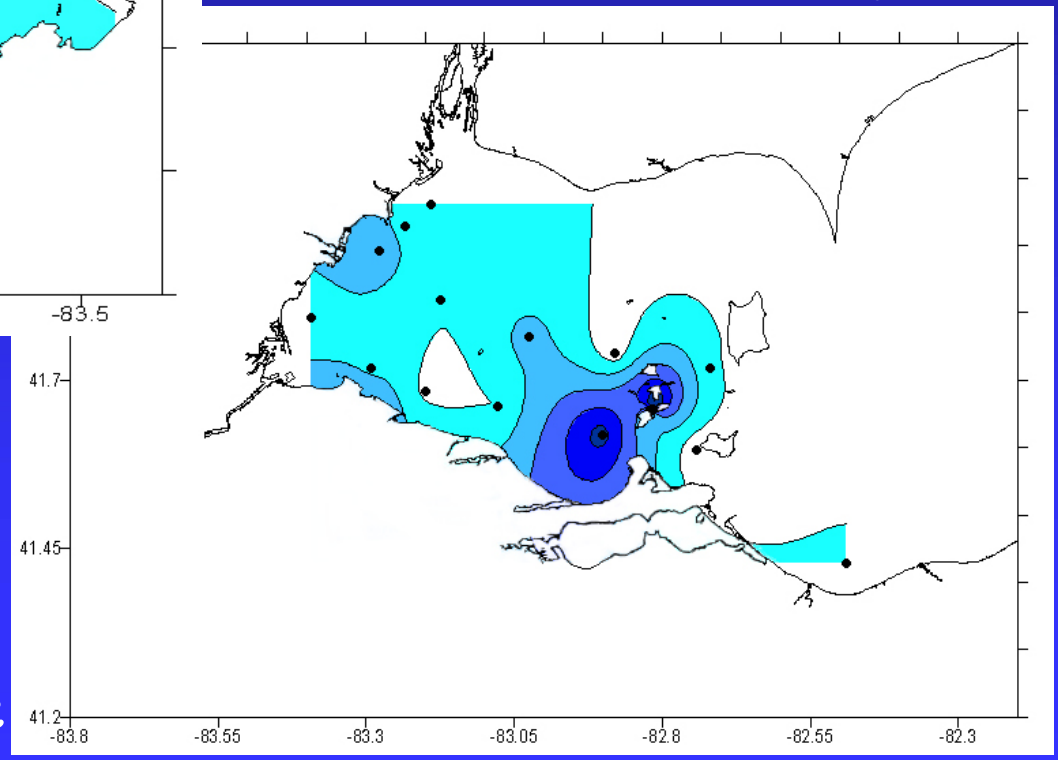
Microcystis cell abundance



Saginaw Bay

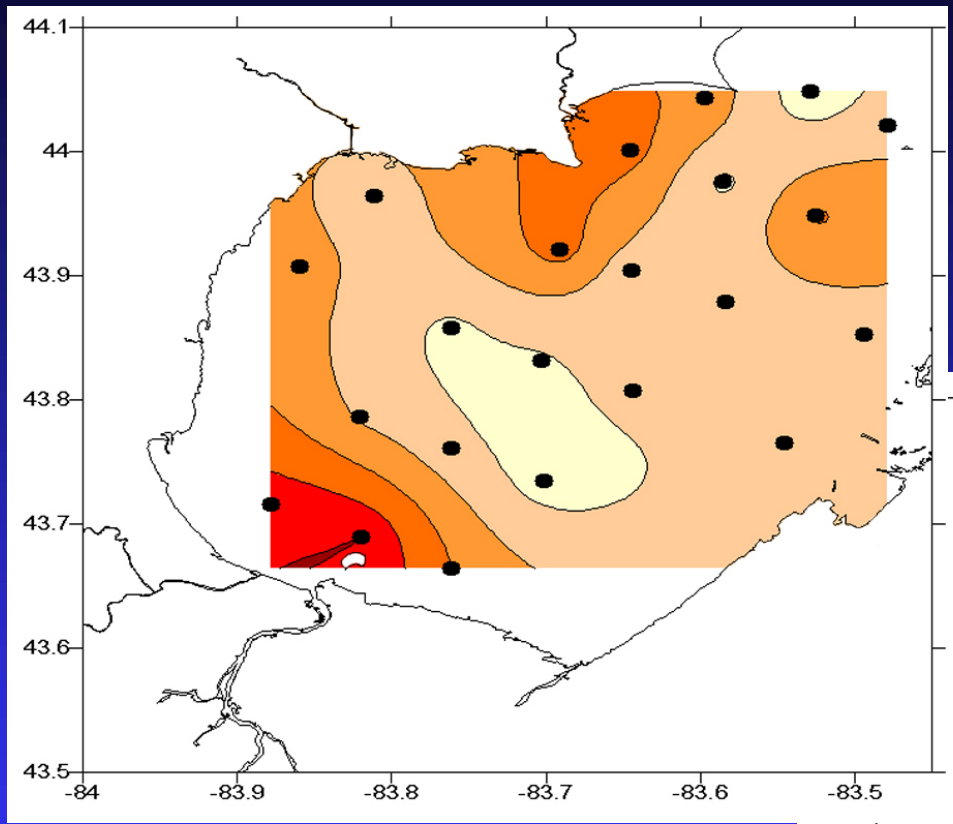


Cell counts by D. Klarer

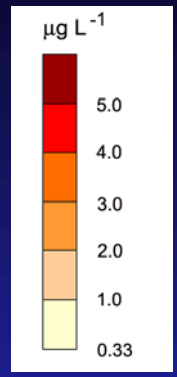


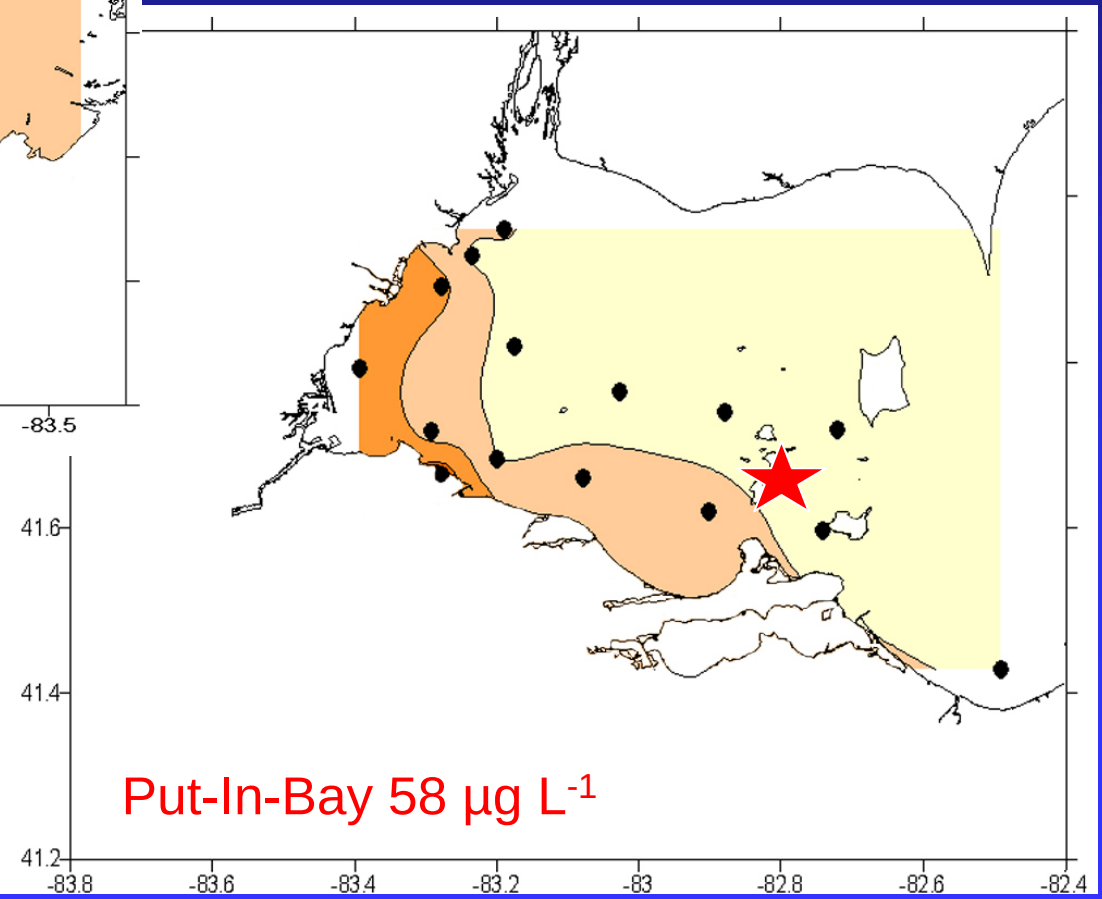
western Lake Erie

Microcystin concentrations in Saginaw Bay



Saginaw Bay

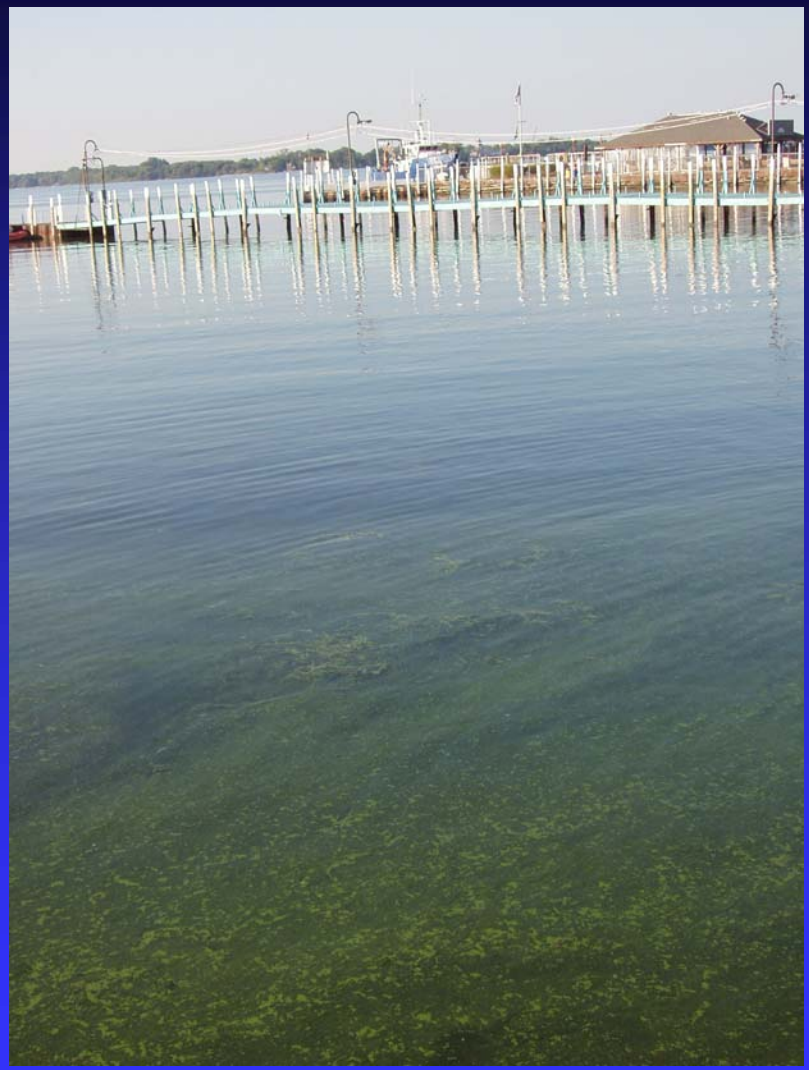




Put-In-Bay 58 µg L^{-1}

western Lake Erie

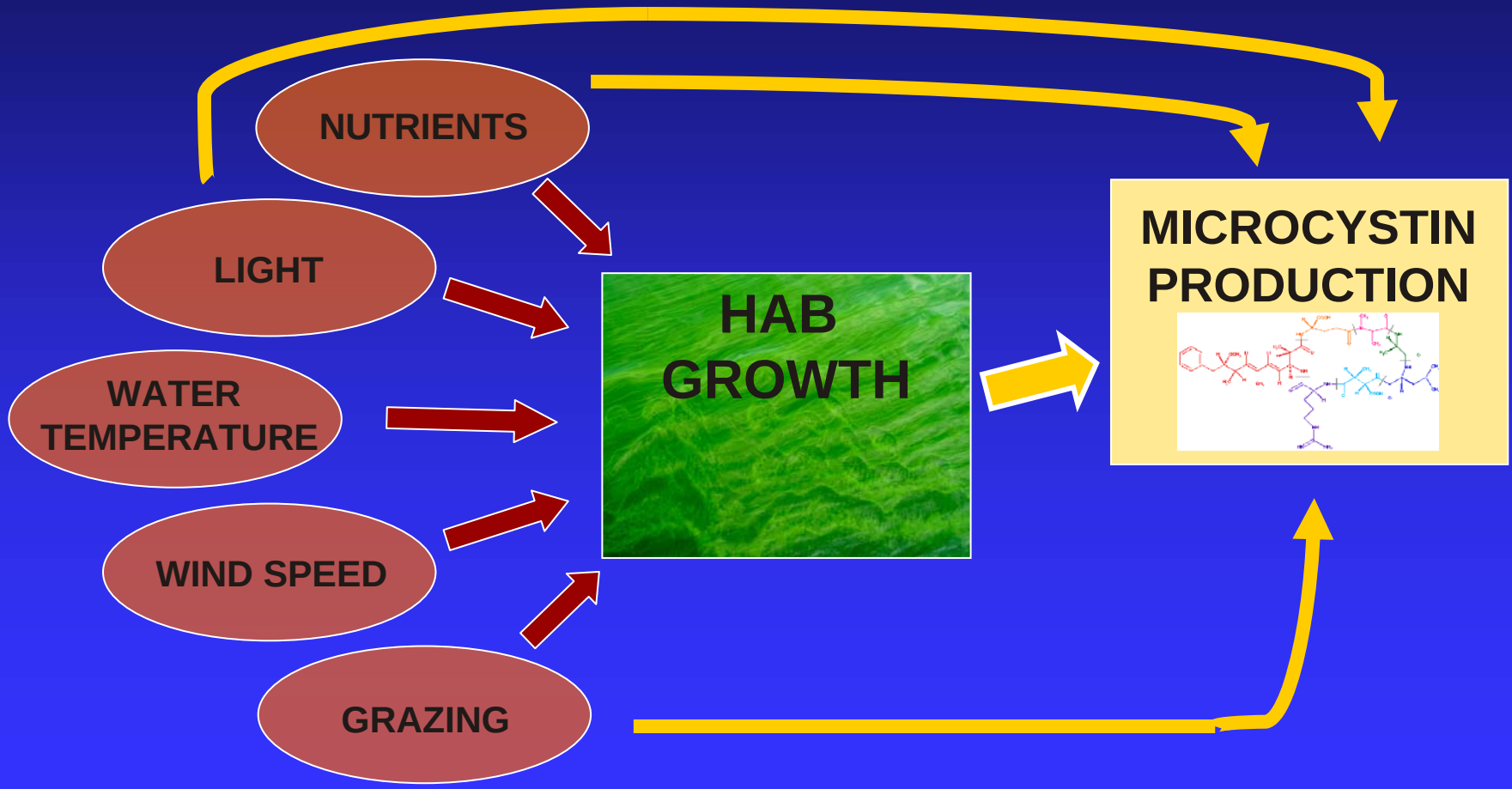
Microcystis in Lake Erie



Put-In-Bay
North shore of S. Bass Island

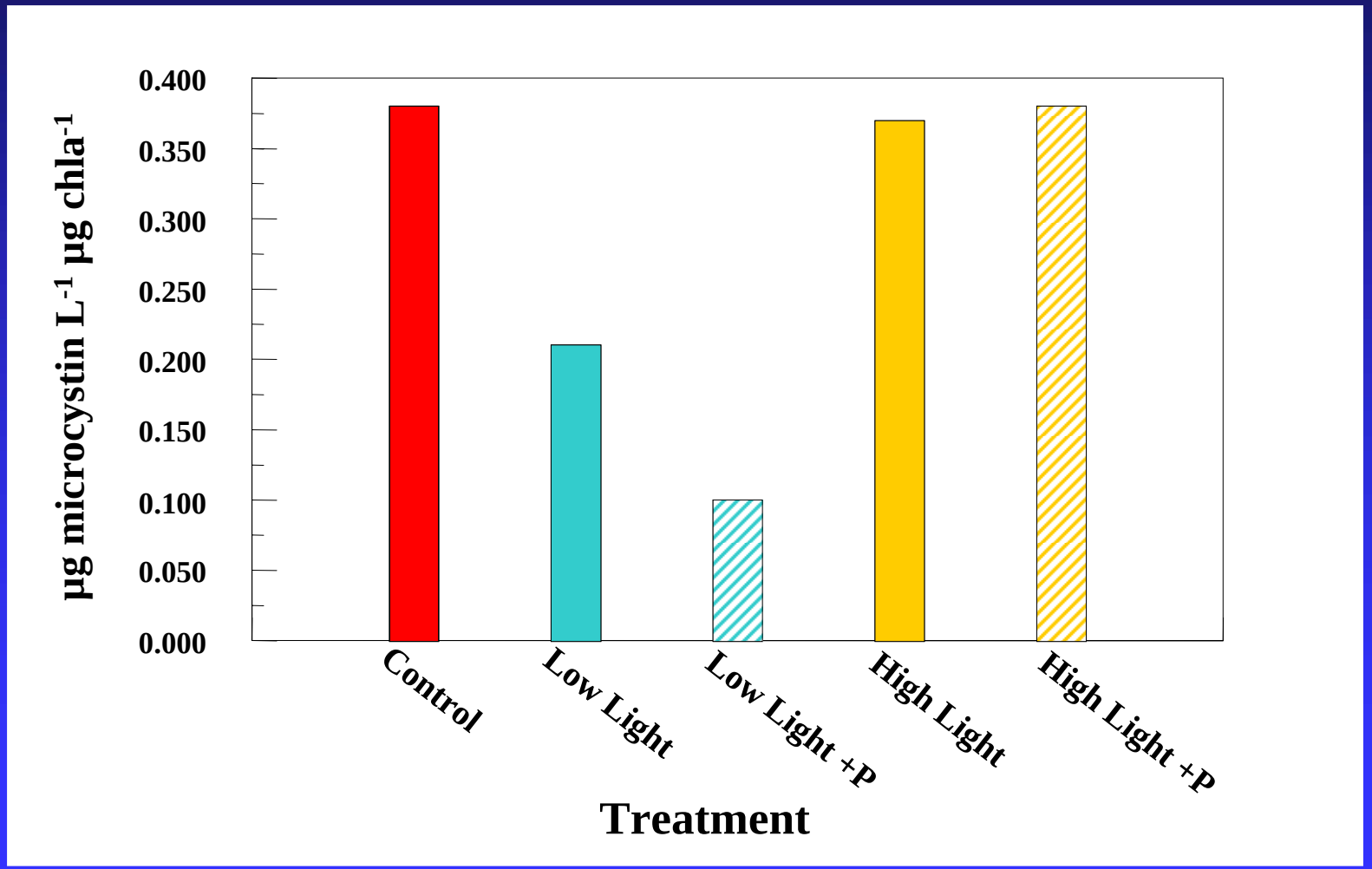
South shore of S. Bass Island

Environmental factors influencing growth and toxin production in *Microcystis*



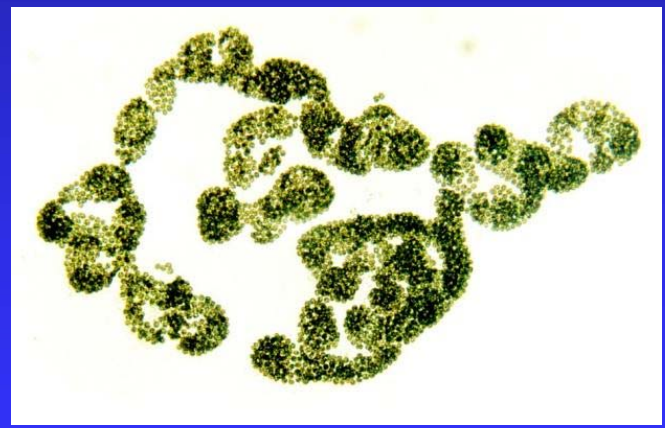
Nutrient (P) and light effects on microcystin production in *Microcystis*-dominated phytoplankton community

Preliminary data, Saginaw Bay, June 2005



Detection with genetic techniques

- Differentiate morphologically identical strains
  - toxic vs. non-toxic
- Track specific populations
  - Geographic origin
  - Genetic diversity
- Rapid detection
  - often faster and less tedious than microscopy



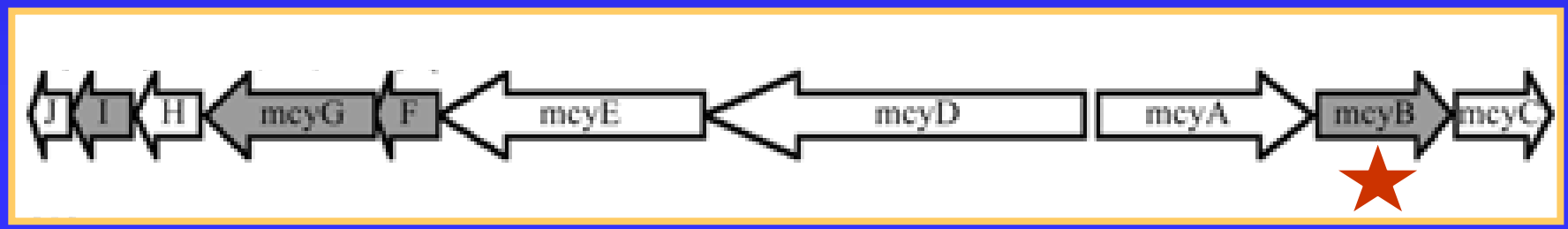
Microcystis sp.

Identifying toxic strains of *Microcystis*

- All toxin-producing strains of *Microcystis* contain genes for microcystin production: *mcyA-J*

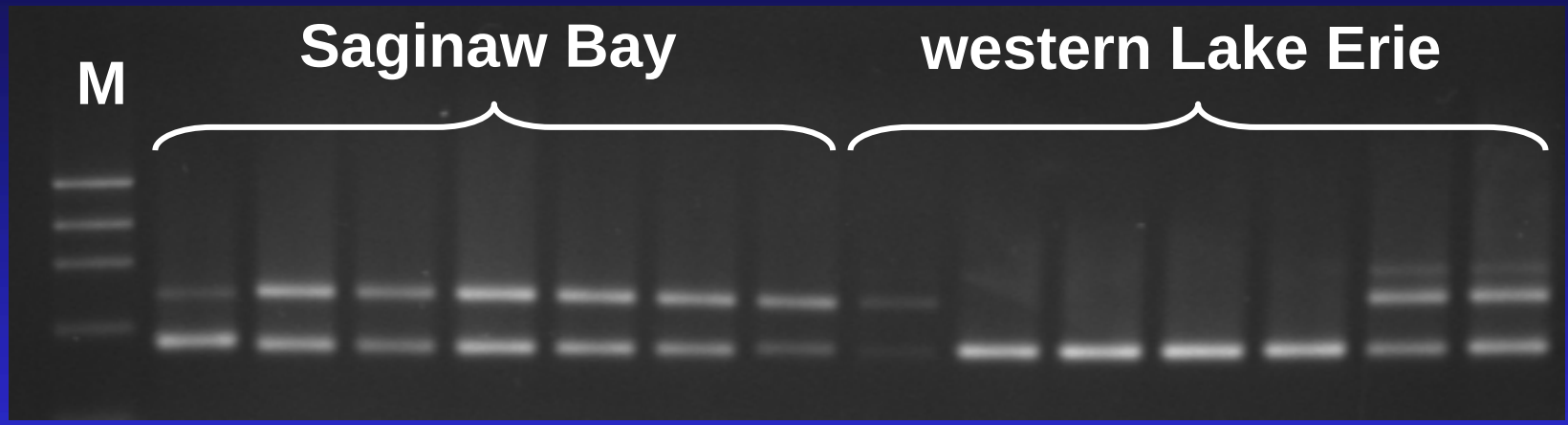
- Presence of *mcyB* = strain able to produce toxin

  Absence of *mcyB* = non-toxic



Pearson et al 2004

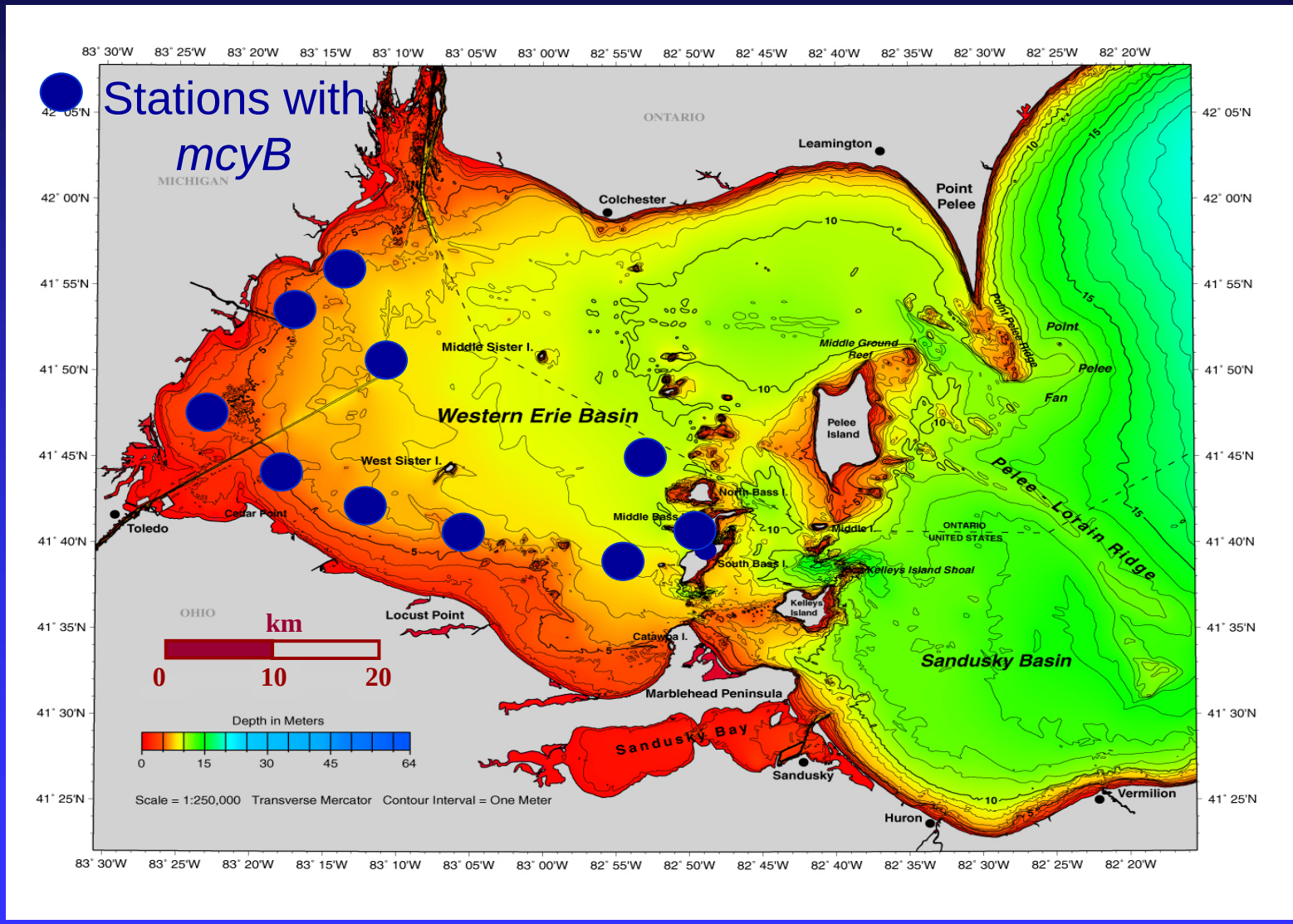
Multiplex PCR for toxic *Microcystis*



M = molecular weight marker

Basin	Number of colonies # mcyB	Number of colonies total	% microcystin producers
Saginaw	36	40	90%
Erie	4	16	25%

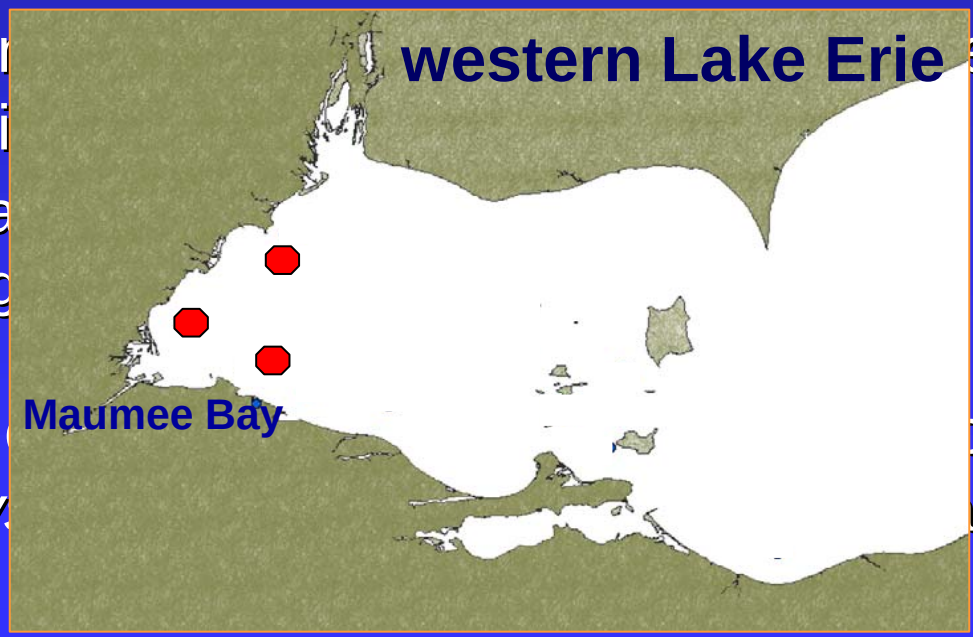
Distribution of toxic *Microcystis*



Develop a quantitative PCR assay for enumerating toxic *Microcystis* colonies

Applications

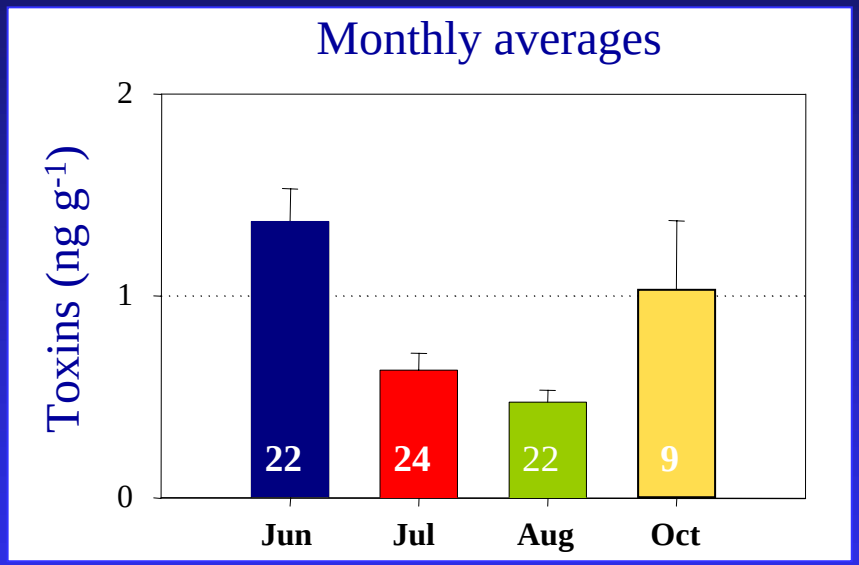
- measure temporal variation in proportion of toxic strains
  - biweekly sampling at 3 locations in western Lake Erie
- identifyi… e actively produci…
  - zebra…
  - chang…
- Tie into … bution of toxic *Microcys*… lity

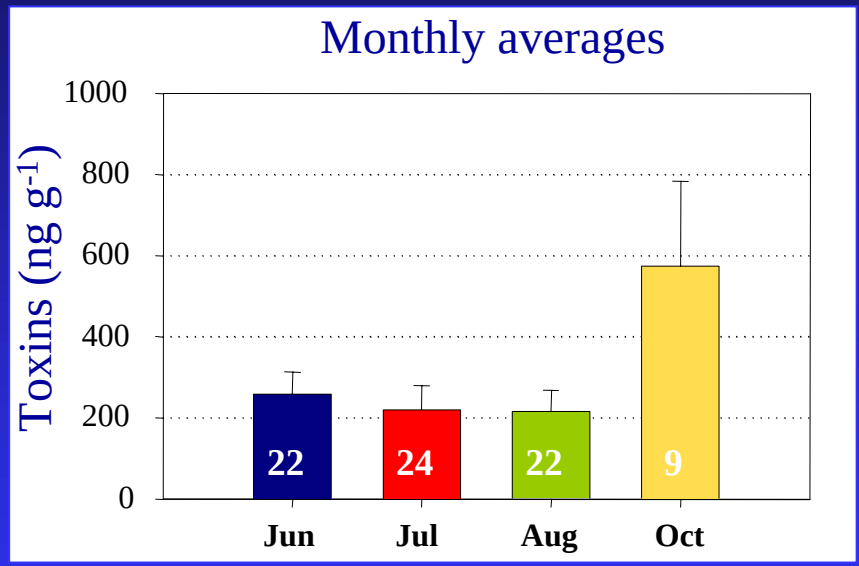


Thanks …….

- Center of Excellence for Great Lakes and Human Health (Oceans and Human Health Initiative)
- Gary Fahnenstiel (NOAA-GLERL)
- Hank Vanderploeg (NOAA-GLERL)
- Pat Tester, Wayne Litaker (NOAA-Beaufort)
- Dave Millie (Florida Institute of Oceanography)
- Crew of the R/V Laurentian
- Sabrina Varnam

Microcystin concentrations in Perch
Lake Erie, summer 2006
ng toxin (g dry mass)$^{-1}$





Muscle

Liver

Microcystin concentration of concern for routine fish consumption = 7.7 ng g^{-1}

Microcystis in the Great Lakes

1970

Dominant member of phytoplankton community
Blooms frequent and abundant
High P input to system (detergents, fertilizers, septic)

1980

P abatement programs (Great Lakes Water Quality Agreement)

1990

Decrease in chlorophyll, increased water clarity
Blooms rare

Dreissenid mussel introduction

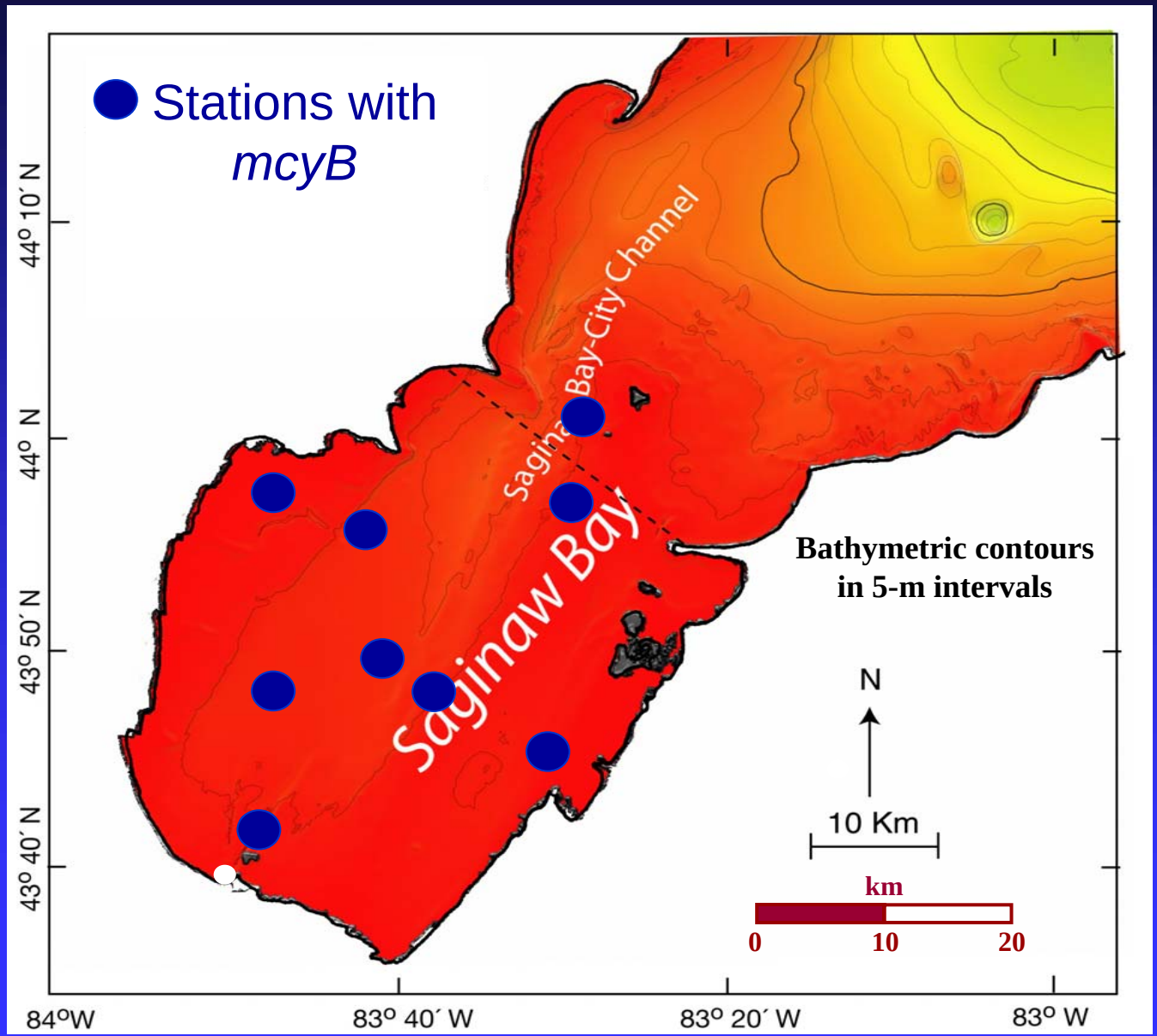
2000

Return of *Microcystis* blooms
up to 90% phytoplankton community

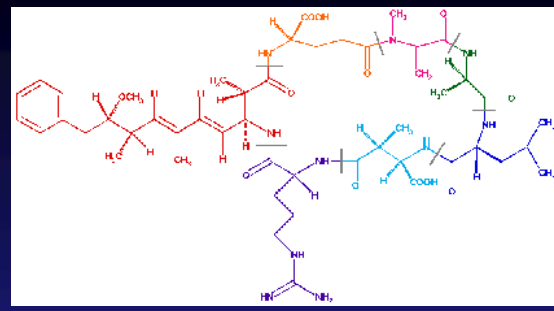
Present

Abundant *Microcystis* blooms, July - Sept

Distribution of toxic *Microcystis*



Microcystin



- Hepatotoxin
  - Over 60 structural variants
- Health effects
  - Animal mortality: livestock, wildlife, birds, pets
  - Human illness:
    - Gastrointestinal, dermatitis (short term exposure)
    - Liver damage (chronic exposure)
- WHO recommended exposure limits
  - 20 μg/L – recreational exposure
  - 1 μg/L – drinking water
- Some evidence of bioaccumulation in fish, mussels and zooplankton